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RECENT CONTRIBUTIONS TO METEOROLOGY.

Report on the Present State of our Knowledge respecting the General Circulation of the Atmosphere. By L. Teisserenc de Bort. (London: Stanford, 1893.)

On Hail. By the Hon. Rollo Russell, F.R.Met.Soc. (London: Stanford, 1893.)

Weather Lore: a Collection of Proverbs, Sayings, and Rules concerning the Weather. Compiled and arranged by Richard Inwards, F.R.A.S. (London: Elliot Stock, 1893.)

WHILE meteorologists are generally prepared to admit the salient points of the theory of the atmospheric motions as outlined by Ferrel, there are to be met discussions by various authors, accentuating not only differences in the details of the scheme, but also defects in the theory on which the general circulation of the atmosphere is based. The latest contribution to the literature of the subject illustrating these points, is from M. Teisserenc de Bort, Meteorologist to the Central Bureau, and General Secretary of the Meteorological Society of France; for this authority cannot accept, in its entirety at least, either Ferrel's deductions or his method of conducting the inquiry. Ferrel, it is well known, having deduced the equations for the horizontal motion of the atmosphere, relative to the earth's surface, applied, with effect, the condition of continuity and the law of conservation of areas, or, what would possibly be a better term, the preservation of the moment of rotation, and demonstrated the existence of an easterly motion of the atmosphere in the higher latitudes, and a westerly motion in the lower. To define the limits of these zones, Ferrel remarked that the sum of the moments with reference to the axis of the earth, of the air forming the easterly winds, ought to be equal to that of the westerly winds, and that this condition was fulfilled on a hemisphere, if the easterly winds prevailed up to 30° latitude, and westerly winds to the pole. This line of argument receives some support from the suggestion, that otherwise there would be a residual unexpended force, tending to change the velocity of the earth's rotation. But M. de Bort replies, with some force, that this argument is inadequate, because there is no evidence that the earth's rotation is uniform; and, indeed, the action of the tides and the diurnal variation of the barometric pressure, point, pretty conclusively, in an opposite direction. If the effects of friction are omitted, the author seems prepared to admit the validity of Ferrel's argument, and it would be very unjust to deny that Ferrel neglected friction altogether, or failed to modify his original result, obtained without friction. Further, Oberbeck especially has considered the effects of friction, and he has assigned a lower limit to the zone of change of direction not greatly different from Ferrel's value. Apart, however, from this point of theory, the author differs from Ferrel as to the cause of the belts of maximum pressure, north and south of the equator, and adds an explanation of the low pressure zone in latitude 55° and of the polar maximum.

But the most interesting, and possibly the most valuable portion of the paper, is the insistance on the connection traced between temperature and distribution of pressure, and the effort to explain the observed variation of pressure along parallels of latitude by the presence of thermic anomalies. The author sees in the variation of temperature over continents and seas in the same latitude, and the consequent changes in the density of the lower strata of the atmosphere, the origin of many of the irregularities that mark the isobaric curves, and a cause not inferior in its effects to the rotation of the earth in establishing the prominent features of the general circulation.

M. de Bort has also made an ingenious attempt to compute from theory the mean isobars of January and July, and to compare the results with actual observations. This is a step in advance, but the measure of success that has attended the effort must be left to the decision of individual judgment. Two approximations, or two distinct attempts, have been made. In the first, it has been assumed that at an altitude of 16,000 feet the irregularities in the distribution of the isobars disappear, and only the influence of latitude remains. Consequently the observed barometric pressure at the surface should be given by adding to the mean pressure, corresponding to the latitude, the weight of the column of air of variable density extending from the surface to this altitude. When this operation is effected, a comparison with the observed quantity discloses the fact that the computed pressures are too great, and further shows a tendency to exaggerate the barometric minimum over the North Atlantic, while it exhibits a maximum of pressure over North America which does not really exist. There is therefore, admittedly, a more marked difference in the computed isobars over continents and seas than is actually observed. Two causes are assigned for the failure to reproduce actual facts, both of which are probably operative. The one is that the density of the column of air does not diminish uniformly with the temperature, which hypothesis, for the purpose of computation, it is necessary to assume. The other is that probably the slope of the surfaces of equal pressure from the equator towards the poles is greater where the temperature is already low, than where the temperatures are high, in the upper regions of the atmosphere.

The second attempt to reproduce the observed pressure is arranged to take into account the influence of the unequal distribution of temperature upon the form of the upper isobars, and it is contended that the computed values of the surface pressure "show close analogy with those representing the isobars deduced from direct observation."

Not content with surveying the conditions of our atmospheric circulation, the author proceeds to discuss those that obtain on the planets, and submits two ideal pictures of the earth with its surrounding cloud as seen from space. These are compared with a photograph of Jupiter, but we strongly doubt whether the author gleans any additional facts in support of his views. The red spot is a conspicuous feature in this photograph, and whatever may be the true explanation of that phenomenon, the tolerable permanence of its character forbids us to ascribe it to atmospheric circumstances. But M. de Bort is disposed to regard the dark markings, in which the red spot would be included, probably, as the real surface of Jupiter, seen through an unobscured atmosphere, and the position of the belts on Jupiter is thought to support the suggestions of the author. But we doubt whether astronomers are agreed that the dark markings represent clear sky, and the lighter portions cloudy vapour. Mars would seem to be the one planet in which we might expect to find atmospheric conditions similar to those here prevalent; but we are told that there are "probabilities based upon scientific reasons, that the clouds upon Mars are not distributed in the same manner as upon the earth." Though when we consider what a presumably comparatively unimportant factor the solar heat is upon Jupiter, and that, moreover, the axis of rotation is nearly perpendicular to the plane of the orbit, on a superficial view, this observation seems to be more applicable to Jupiter than to Mars. From the remark with which the paper closes, we gather that the author intends to prosecute this subject of investigation on the planets. We wish him success.

Of the second work mentioned at the head of this notice, it is rather difficult to speak. Although the author has not sketched the plan and scope of the work in any introductory chapter, it is easy to understand the principle that has guided him in the construction of the book. He has evidently been at great pains to bring together all that is valuable, or that he thought valuable, in the descriptions that have been given of hailstorms in the past, not only in the accompaniments of the hailstorms, or of the characteristics of the hailstones themselves, but also of the theories that various authorities have suggested to explain their occurrence. When we consider that in the case of nearly every hailstorm, some one is found to describe it, it is evident that the materials from which Mr. Russell can draw his information are very widely scattered. The list of authors quoted is a long one, and could no doubt have been made much longer, did not the reiteration of the same facts become wearisome. Having collected his information, the author has attempted to digest it, and has given us a summary of the characteristics of hailstones with a graphic description of the development of a hailstorm. One consequence of this method of dealing with the subject is that about three-fourths of the book consist of extracts from various authors, and only the remainder is original matter. This class of work, if not very brilliant, is, no doubt, valuable; and inasmuch as most of the extracts are given in the words of the author, with distinct references to the sources from which they are taken, this book may save much searching of original authorities, and a proportionate saving of time. Whether the materials are arranged in the most advantageous manner, is a question about which some doubt may be entertained. It would seem sometimes as though the extracts had been printed in the order in which they had been encountered, without any attempt at arrangement at all. To take the first chapter, "descriptions of hailstorms and hailstones," at first sight it would look as though some chronological order was to be maintained, for we begin in 1680, and pass next to the early years of this century; but when we get into the middle of the century, we flounder about from 1890 to 1870, and back again, without any guide. Neither is locality any rule, for we are taken all over the world, without method or system. Nor is it easy to trace any gradual scientific progress in the descriptions. We have simply more or less complete descriptions of some fifty hailstorms, or of the salient features that distinguished them.

The second chapter gives us observations of temperature, clouds, and winds at great altitudes, principally confined to the accounts of balloon ascents. In this chapter, which is very short, there might have been found room to discuss in more detail the observations made at some of the meteorological stations at considerable altitudes. The results obtained at Pike's Peak, Colorado, would seem to be of the highest importance in this connection; but the author prefers to drop this topic, though apparently germane to his subject, in order to discuss, or rather to collect, the opinions and observations of those meteorologists who have noticed the connection of electricity with the occurrence and formation of hail.

The chapter on theories of hail is interesting. In it is given the opinions of most of those whose opinions are worth recording, but in the popular and not the scientific language which some of the authorities quoted would have used. Von Bezold especially suffers from inadequate description, and, if we are not mistaken, Hertz's name is not mentioned. It would seem almost as though the author were not acquainted with much of the hydrodynamical analysis that has been applied to the atmosphere, or being acquainted with it, disapproves of its application to the present inquiry.

In the chapter on the development of a hailstorm, objection will probably be taken to the insistance and stress that is laid upon the part played in the mixture of air of different temperatures, as a primary cause in producing precipitation, whether it be of hail or any other form of moisture. The numerical example worked out to illustrate the author's point is not very clearly expressed; and even granting the figures of the author, he is obliged to fortify his case by a continual mixture. But the continual mixture would tend to produce uniformity of temperature, and disturb the accuracy of the original calculations. Undoubtedly we have present, in what it is usual to call the hail stadium, an amount of dry air which it is convenient to separate, in theory at least, from the saturated vapour also present, the drops of water, and the particles of ice or snow which probably constitute the germ of the large hailstones, and then, if the conditions are favourable, we get hail; and it is difficult to see that our author has carried the explanation much further. Nor possibly does the application of the mechanical theory of heat, however legitimate its methods may be, advance our knowledge very materially, at least in a practical direction. The local, and often confined, area over which hailstorms occur, is a marked feature of their occurrence, and is likely, for a long time to come, to baffle the applications of a general theory, and prevent any sufficient precautions being taken against the damage they produce, which it may be supposed is the practical outcome that sufferers hope to derive from the studies and inquiries of meteorological observers.

In the final chapter, headed "Conclusions," there is an attempt to gather up the results of the observations recorded in the previous chapters. It is a pretty fair record of our general knowledge of the subject, exhibiting a tolerably complete grip of all the circumstances attending these phenomena. It does not show much originality, perhaps, but it does show very extensive reading, accurate observation, and power of condensation.

The third book mentioned is scarcely of the kind that compels one to sit down and read off-hand. It is precisely what it professes to be—a collection of the many weather proverbs which possibly the wit of one, rather than the wisdom of many, has perpetuated. If these adages did contain the results of long-sustained and well-directed observation of the habits of birds, animals, and insects, they would possess a distinct value, though it is difficult to see how the information so gleaned could indicate the severity or the mildness of the coming season; but it is to be feared they too frequently record the opinion of one who is capable of a jingling rhyme, or of one whom his comrades consider to be wise in such matters.

There are also quotations from the poets, ancient as well as modern, and all bearing on the subject of weather prediction. The hope of the author is that the perusal of such a collection may induce students to take more intelligent notice of meteorological conditions, and to avail themselves of accurate instrumental means, rather than to rely upon hackneyed quotations. A somewhat similar collection of "wise saws" was published by the United States Signal Service, but we fail to see any reference to this work in Mr. Inwards's introduction. A study of these sayings would probably furnish some additional quotations, and as the compiler aims at greater completeness in the next edition, we would refer him to this source. The book is well printed and admirably "got up," and will no doubt be welcome to many interested in folk and weather lore.

PHYSICO-CHEMICAL MEASUREMENTS.

Hand- und Hilfsbuch zür Ausführung physiko-chemischer Messungen. Von W. Ostwald. (Leipzig: W. Engelmann, 1893.)

THIS manual must be regarded as the only guide to measurements in physical chemistry which has yet been published. The book is not intended to completely cover this field of investigation, but has evidently been devised with the primary object of assisting Prof. Ostwald in his course of instruction at Leipzig. It is not an introduction to the subject, as the detail supplied, both in connection with apparatus and methods, is insufficient for the requirements of the beginner; nor is it a treatise wherein a representative collection of methods may be consulted. The book is rather to be viewed as an aid to the teacher, or as indicating to the chemist or the physicist methods which for the most part the author has found to be of service in his own laboratory.

The information contained in the opening portion of the volume is of the kind usually met with in a physical text-book: modes of calculating results, the influence of errors, the use of corrections, the measurement of length, the balance and weighing, and the measurement and regulation of temperature. Succeeding chapters take up he more common operations in glass-working, the measurement of pressure, the measurement of the volume and density of solids and liquids, and the ordinary methods of measuring vapour density. Here it may be noted that Perkin's modification of Sprengel's pyknometer, which is perhaps the most useful of all the various patterns, is not included among those described. Kopp's pyknometer also is rendered more serviceable if a short mm. scale instead of a single mark be etched on the neck.

The thermal properties of liquids are next briefly considered. Modes of determining expansion and molecular volume at the boiling-point are given with a moderate amount of detail. The determination of the boiling-point itself is, however, described in the most meagre way. Of the various methods of measuring vapour pressure the dynamical process introduced by Ramsay and Young alone finds a place. Critical temperature and critical pressure are determined in separate pieces of apparatus in the manner recently described by Altschul. No general method is indicated whereby the relation between pressure and volume may be determined under varying conditions of temperature, and no practical method can thus be given for estimating critical volume, although the principle of the new method due to Mathias is mentioned.

Calorimetry is now dealt with, and short accounts are given of the simpler methods of estimating specific heat and the thermal changes accompanying vaporisation, dissolution, combustion, and reactions in dilute solution.

Descriptions of optical measurements relating to refractive indices, spectroscopy including spectrum photometry, calorimetry, and rotatory polarisation are now introduced, and are followed by a chapter on viscosity and surface tension. In connection with viscosity, the apparatus represented is only adapted for obtaining relative values, and is quite unsuited for investigating the effect of temperature. What appears to be the correct value of the kinetic energy correction used in calculating viscosity coefficients is ascribed to Finkener and Wilberforce, whereas the first published account of the mode of deducing it is due to Couette. None of the methods given for measuring surface tension are free from the objection that air is in contact with the liquid surface.

The remaining chapters are devoted to measurements on solutions. Methods of estimating the solubility of solids, liquids, and gases, and of determining molecular weights from the freezing-points and boiling-points of solutions are given at considerable length. At still greater length, and thus in marked contrast with the treatment elsewhere, electrical measurements are next set out. Here are found accounts of the methods of measuring electromotive force and conductivity, dissociation constants, the basicity of acids, &c. The last chapter takes up elementary problems in chemical dynamics relating to the velocity of chemical change, the catalysis of methyl acetate and the inversion of cane-sugar by dilute acids being given as examples.

From what has been said it is evident that the operations dealt with in the book are only such as are frequently performed, or which at the present time are considered to be of importance. Some of these even are